INTELLIGENCE COMMUNITY
2006 POSTDOCTORAL RESEARCH FELLOWSHIP PROGRAM
FOR NON-PROFIT/NOT-FOR-PROFIT ORGANIZATIONS
NGA Broad Agency Announcement (BAA) HM1582-06-BAA-0002

OVERVIEW INFORMATION

Federal Agency Name: Department of Defense, National Geospatial-Intelligence Agency (NGA), InnoVision Directorate, Office of Basic and Applied Research

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Concise Description: This Broad Agency Announcement by the National Geospatial-Intelligence Agency announces the Director of National Intelligence (DNI)/Intelligence Technology Innovation Center (ITIC) Fiscal Year 2006 competition for the Intelligence Community 2006 Postdoctoral Research Fellowship Program. The Program was created in response to the Intelligence Community (IC) requirement to address long-term IC research and technology needs. The Program serves the IC and research communities by engaging experts in the solution of problems critical to IC goals and missions. Science and technology are fundamental drivers of global developments, and the IC Postdoctoral Research Fellowship Program facilitates the necessary research in leading-edge technologies to support broad Intelligence Community technology needs. The Program awards multi-year postdoctoral research fellowships to address these needs. The mission of the IC Postdoctoral Research Fellowship Program is to establish long-term relationships and mentoring of postdoctoral researchers and to provide research institutes with an understanding of the Intelligence Community's research requirements. The program fosters partnerships with postdoctoral researchers as they move into career positions and provide innovative solutions to critical Intelligence Community problems.

Anticipated Amount/Number of Awards: Through this competition, NGA/ITIC expects to make three or more contract awards in several specific research topics as described herein. The level of the contract awards is up $240,000 for a two-year contract.

Who is Eligible to Apply: Applicants must be associated with a U.S. domestic, non-profit/not-for-profit organization (applicants associated with a U.S. domestic college, university or other degree-granting institution should apply under NGA BAA HM1582-06-BAA-0001). The Postdoctoral Fellow must be a U.S. citizen.

TABLE OF CONTENTS

I. FUNDING OPPORTUNITY DESCRIPTION

A. Introduction

The Director of National Intelligence (DNI) and ITIC announce a Fiscal Year 2006 competition for the IC Postdoctoral Research Fellowship Program.

In 2000, the Director of Central Intelligence (DCI) established a Postdoctoral Research Fellowship Program within the Central Intelligence Agency's (CIA) Directorate of Science and Technology (DS&T), Intelligence Technology Innovation Center (ITIC) Staff. The Program was created in response to the Intelligence Community (IC) requirement to address long-term IC research and technology needs. Now called the IC Postdoctoral Research Fellowship Program, the Program serves the IC and research communities by engaging experts in the solution of problems critical to IC goals and missions. Science and technology are fundamental drivers of global developments, and the IC Postdoctoral Research Fellowship Program facilities the necessary research in leading-edge technologies to support broad Intelligence Community technology needs.

The mission of the IC Postdoctoral Research Fellowship Program is to establish long-term relationships and mentoring of postdoctoral researchers and to provide research institutes with an understanding of the Intelligence Community's research requirements. The program fosters partnerships with postdoctoral researchers as they move into career positions and provide innovative solutions to critical Intelligence Community problems.

The National Geospatial-Intelligence Agency's (NGA) InnoVision Directorate is the executive agent for the IC Postdoctoral Research Fellowship Program. NGA's role as executive agent includes posting this Broad Area Announcement (BAA), managing the proposal review process, and using the Agency's contracting and acquisition authority to make awards in the program.

The DNI expects that IC Postdoctoral Research Fellowship Program projects will promote application of research primarily for intelligence purposes. The first phase of this competition was completed in October 2005 with an internal Call for Research Topics. Intelligence agencies – CIA, NGA, NRO (National Reconnaissance Office), NSA (National Security Agency), DIA (Defense Intelligence Agency) and the DNI's (Director, National Intelligence) two research groups, ITIC and DTO (Disruptive Technology Office) – all identified Federal employees interested in making a commitment to serve as an Intelligence Community Advisor (mentor) for a minimum of two years. Intelligence Community Advisors submitted their resumes and proposed research topics that will draw highly-qualified postdoctoral fellows for Intelligence Community-related research. These research topics are listed in paragraph I. B.

This Broad Agency Announcement – the Call for Research Proposals – is the second stage of the Program Call and is a funding opportunity for qualified postdoctoral research investigators interested in research support in the specified topical areas.

B. Specific Research Topics for the FY2006 IC Postdoctoral Research Fellowship Program

The 47 topics that follow represent the Intelligence Community's research interests that are particularly suited for investment this year. An award in any topical area will be made only if a sufficiently meritorious proposal is received. ITIC reserves the right to allocate available funds among topics based on the quality of the responses and priorities. A detailed description of each topic with Point of Contact (POC) data is presented in following paragraphs.

In the following section, this BAA describes research areas, comprising some of the Intelligence Community's most current technology interests. These descriptions provide offerors with a frame of reference and offerors are encouraged to submit innovative ideas that address these interests. Offerors also are urged to consider the research issues posed and, as appropriate, to contact the identified individuals to discuss potential efforts. Inquiries are welcome. Note that while links to contacts for each topic are available on the website (www.icpostdoc.org), **all proposals must be submitted only to the addressees shown in paragraph IV. D.**

1. Solid Electrolyte Interphase (SEI) Studies of Lithium-Ion (Li-Ion) Cathodes and Anodes

Questions about Topic 1 can be e-mailed to: topic1@icpostdoc.org

Proposed Research Project:
Quantitatively and qualitatively analyze the organic components of the SEI formation in cycled Li-Ion anodes and cathodes.

Technical Objectives:
The emphasis for this program will be in the following areas.

A previous IC (formerly DCI) Postdoctoral Program used high field NMR to identify the inorganic salts and phosphate compounds found in SEI layers. In this program we would like to investigate the **organic** components of Li-Ion SEIs.

- The first objective of this program is the identification and quantification of the organic components of SEI layers of selected/provided Li-Ion electrodes.

- A second objective of the program is to study the effect of electrolyte additives on Li-Ion SEI formation in both cycling and accelerated aging tests to determine if any of them might increase cycle life.

Goals:
The goal of the project is to provide a detailed quantitative and qualitative analysis of SEI formation in cycled Li-Ion cathodes and anodes. Such knowledge will enhance our understanding of the failure mechanisms in long cycle life Li-Ion cells and help us achieve better cycle life in future Li-Ion cells.

2. Knowledge Representation and Ontology Research

Questions on Topic 2 can be e-mailed to: topic2@icpostdoc.org

Proposed Research Project:
Ontologies are one way of structuring knowledge about a domain or topic of interest. Ontologies that are designed for natural language processing systems support deeper analysis of the content and context of documents. This project will focus on developing the knowledge structures, resources and processes for a selected knowledge distillation task, for example, a scenario-driven extraction task, such as characterizing *meeting events* in a corpus -- who met with whom, what is the topic of the meeting, when and where did it take place, and what was the purpose.

Technical Objectives:
There are several dimensions to this research, and the postdoctoral research fellow may focus on one or more aspects listed below, in coordination with the IC Advisor:

- **Knowledge Representation** -- determining the kinds of knowledge that must be represented in an ontology to support the automatic analysis of elements of meaning in text for a particular knowledge distillation task. Supporting tasks include:
  - Evaluation of current linguistic ontologies, evaluating their expressiveness, coverage and gaps
  - Evaluation of current "upper model ontologies"
  - Evaluation of existing ontological tools, and selecting and or adapting the best one for the project
  - Selection of a domain and task for ontological modeling and knowledge distillation
  - Design of a scenario-driven template for the knowledge distillation task

- **Knowledge Acquisition** -- acquiring the concepts that are needed to support the knowledge distillation task. Supporting tasks include:
  - Expansion of the ontological inventory of relations between entities
  - Extension of the concept modeling of events and scenarios, which are often weakly represented in existing ontologies
  - Exploring ways to represent various kinds of contextual knowledge in an ontology, such as temporal relations, discourse relations, social relations, speaker attitudes and beliefs, and cultural and stylistic knowledge
  - Acquisition of other domain-relevant concepts that are absent in the existing ontology
  - Annotation of a corpus with ontological concepts to support machine learning algorithms that could be trained to automatically reproduce the annotation on new documents. This effort will leverage on-going annotation efforts in the NLP community. Depending on resources available, this may be done on a multilingual corpus, to ensure that the ontology design supports multilingual text processing.
  - Investigation into techniques for automatically deriving ontological concepts from corpora, or accelerating manual acquisition

  - Investigation of techniques for semi-automated ontology alignment and merging.
  - Improving graphical visualization and navigation of ontologies

- **Knowledge Distillation** -- developing the algorithms to automatically process and extract key elements of information from texts, using the acquired ontology. Supporting sub-tasks include:
  - Semantic parsing of documents, with links between the lexicon and ontology
  - Developing inferencing and reasoning rules based on the ontology
  - Extracting the relevant information to fill the scenario-based template

- **Evaluation** -- The project will evaluate current linguistic ontologies along several dimensions to be defined. In addition, there will be an evaluation of the information extracted by the system against a pre-defined set of gold-standard answer keys produced by humans.

Goal:
The goal will be to demonstrate the "added value" of using an ontology for processing documents, for example, by being able to reason over the documents and make inferences that wouldn't be possible without the ontology.

3. Small, Long-life Micropower Sources

Questions on Topic 3 can be e-mailed to: topic3@icpostdoc.org

Proposed Research Project:
As the size and weight of electronics are reduced, the size and weight of the power sources needed to operate them have not kept pace. In addition to the direct impact of scaling on volume of active material, the total energy that one can store in a small volume is disproportionately reduced because of the packaging overhead. One potential option for providing meaningful levels of energy in small long-life devices is to couple some form of power harvesting with effective conditioning and storage devices.

Technical Objectives:
Our interest lies with power system volumes on the order of ½ cm^3 to 1 mm^3 in various form factors. Systems could be small in one, two, or three dimensions, and even adapt in shape to suit a particular environment. Power levels on the order of micro to milliwatts are of greatest interest. The source of this power can be thermal gradients, RF, or mechanical vibrations or some combination of these sources. Photovoltaic solutions will not be considered for this topic.

Goals:
Proposals are sought that build integrated demonstration devices and address the following issues: what are the limits to power harvesting and storage at small scale under a range of environmental conditions? What role can multifunctionality plan in these highly integrated systems? To what degree can systems be effectively optimized *in situ*?

4. Hybrid Processing for Remote Sensing

Questions on Topic 4 can be e-mailed to: topic4@icpostdoc.org

Proposed Research Project:
Technological advances in sensors have resulted in autonomous sensors that produce data at extremely high rates. Processing of this data in the field in real-time is not currently possible, and remote processing of the data requires unrealistically large data links.

The goal of this project is to develop ultra low-power and compact analog VLSI signal processing systems suitable for real-time processing of remote sensing data at the point of acquisition or for use in on-board, real-time processing.

Technical Objectives:
Design, fabricate and test a hybrid signal processing chip set suitable for integration into a very high data-rate remote sensing device (such as a hyper-spectral imager) that drastically reduces the post-collection processing requirements with no significant increase in the sensor size, weight, or power requirements and/or design, fabricate, and test of a chip set that significantly enhances the autonomous capability with only marginal changes in it's size, weight, or power requirements.

Goals:
Enhance the timeliness and utility of high-performance remote sensing systems by incorporating significantly more processing power into them.

5. Negative Refractive Index in Organic Crystals

Questions on Topic 5 can be e-mailed to: topic5@icpostdoc.org

Proposed Research Project:
The purpose of this research is to conduct theoretical and experimental investigations into the creation of negative index of refraction materials using organic molecular crystals. Laboratory investigations have found that molecular crystals of particular organic chromophores may exhibit strong excitonic coupling leading to a significant splitting between exciton levels. The coupling between the energy levels may be driven by an oscillatory coupling field. The result of which is an organic crystal with a spatial dispersion which can lead to a negative group velocity. The criteria that the material shows a negative group velocity dispersion and a negative permittivity shall also be investigated experimentally and theoretically. Previous theoretical analysis suggest that the situation for the molecular crystal may relax the requirement for negative permittivity for the very tight focusing of a beam as a result of negative group velocity.

Technical Objectives:
Investigate (both theoretically and experimentally) the potential of organic material to show negative group velocity dispersion and negative permittivity (and the possibility it can be relaxed).

Investigate the effect of the group velocity dispersion in organic molecular crystals

Goals:
Demonstrate and characterize a new approach for developing negative refractive index materials with the goal of implementing perfect lenses for very tight focusing of a beam.

6. Development of Low-Loss Meta-materials for Microwave Application

Questions on Topic 6 can be e-mailed to: topic6@icpostdoc.org

Proposed Research Project:
The IC Postdoctoral Research Fellowship Program seeks ideas for understanding and reducing losses in NIR metamaterials, particularly for new applications at microwave frequencies.

Russian physicist Victor Veselago made predictions of new optical properties of materials with a Negative Index of Refraction (NIR) in the 1960's. Not until the late 1990's did experimental realizations of these materials appear in the form of artificial cellular structures, or "metamaterials". Now there is great excitement about using NIR metamaterials for new Radiofrequency (RF), microwave, millimeter-wave, terahertz, far-infrared and optical applications. These applications have the potential to revolutionize our use of the electromagnetic spectrum, and could have an impact on intelligence collection and covert communication. However, the effects of losses are clearly limiting the ability of these metamaterials to act as "perfect lenses" and to amplify evanescent waves, the key features that enable new technologies.

Technical Objectives:
Ideas for understanding and reducing losses in NIR metamaterials, particularly for new applications at microwave frequencies are encouraged. Approachs that investigates low loss metamaterial behavior from RF to microwave frequencies will be considered. Also of interest are ideas for minimizing loss and reducing the cell size of metamaterials to the micron scale. The insight gained from investigating low-loss miniaturized metamaterial behavior should lead to practical applications.

Goals:
The technical goal of this project is the experimental development of a low-loss metamaterial whose negative refractive properties are substantially better than current metamaterials, or whose properties are equal to current metamaterials, but which have substantially reduced cell size.

7. Sensing Platforms for the Multiparameter Analysis of (Bio) molecules and Pathogens: Technology Integration

Questions on Topic 7 can be e-mailed to: topic7@icpostdoc.org

Proposed Research Project:
The purpose of this research is to investigate integrating various technologies across nano, micro and macro scales, into a single multi-parameter sensor platform. Some of the most promising technologies for the detection of (bio) molecules and pathogens are based on libraries of all-electronic, quantitative detection devices for sensing the (bio) molecules or pathogens of interest. However, a fully developed version of one of these platforms would be comprised of at least three separate technologies, all integrated into a single package, which cross nano, micro and macro scales. Over the past several years, significant effort has gone into the development of the individual components of such an integrated package – i.e. the sensors, the chemistry, and the fluidics devices are all advancing at a rapid rate. However, very little effort has been devoted towards integrating these separate technologies into a single package. Such integration is a major bottleneck towards the full development and validation of these platforms. It also constitutes a challenging scientific and engineering problem. For example, the fabrication or nanofabrication techniques used to fabricate the sensors may not be compatible with the chemical approaches used to encode the sensors. Fundamental materials issues, such as the compatibility of the electronics and fluidics materials with the samples of interest, can also provide challenges. Equally important is that all of materials and the chemical and fabrication steps should be eventually adaptable towards high through-put manufacturing.

The proposed IC Postdoctoral Research Fellow would take on the problem of integrating these various technologies into a single multi-parameter sensor platform that could be tested and validated. The Fellow would need to be strongly motivated to work across a number of historically distinct disciplines, and should have the capability to take a 'systems' approach to this problem.

Technical Objectives:
- Identify and resolve (both in theory and via experimentation) integration issues across nano, micro and macro scales for the detection of (bio)molecules and pathogens:
    - At the device level (e.g., capacitance and impedance mismatches between molecules, nanowires, and microwires).
    - At the design and interconnect level.
    - At the fabrication level.
    - In the packaging of an applications system or product.
- Provide satisfactory demonstration of these issues' resolution through appropriately constructed proof-of-concept experiments.

Goals:
Identify and develop enabling technologies to overcome challenges inherent to integrating multi-scale (bio) molecule and pathogen detection systems leveraging key nano-scale building blocks.

8. Cognitive Radio Research

Questions on Topic 8 can be e-mailed to: topic8@icpostdoc.org

Proposed Research Project:
Achieving optimal use of the radio spectrum with cognitive radios will be challenging due to, in part, the large number of operating dimensions to consider in the solution (frequency, time, directionality, modulation, quality of data service, and code structure). The rapid changes in the utilization of unoccupied bands and timeslots, and the need to collect spectral information distributed in both small- and large-scale regions will also represent challenges. Cognitive radio development will further by complicated by the security needs of both the defense and intelligence communities.

Technical Objectives:
Provide insight into the practical advantages of new or existing cognitive radio technologies. Further, interest is in the advantages that accrue from the application of the proposed research over those available in emerging commercial and military software-defined radio technologies.

Goals:
The goal of this research topic is to advance and apply cognitive radio technology to IC applications.

9. Unlocking the Information Content in Graphs and Charts – Automatic Content Extraction and Duplicate Detection.

Questions on Topic 9 can be e-mailed to: topic9@icpostdoc.org

Proposed Research Proposal:
This proposal is to study how to synergistically fuse technologies from image processing and artificial intelligence to develop a capability for Graph and Chart Understanding that can be used to intelligently index into large, distributed databases of charts and graphs to answer queries about their content and to identify documents having, essentially, duplicate information and knowledge. The field of content-based image retrieval is concerned with developing methods for the specification and processing of queries to index into databases of images based on their visual content. Little research has been conducted on techniques that would support indexing into databases of images of charts and graphs, even though the information depicted by them represents a rich source of easily assimilated knowledge for analysts. There is a strong foundation of research in image processing and artificial intelligence that could be employed for analyzing such data and constructing deep representations of their content that could be used to develop retrieval systems. The information that can be obtained by such documents and which could be sued as a basis for indexing algorithms includes:

- The independent and dependent variables represented by the chart or graphs,
- The values of the dependent variable, represented in some suitable format such as a spreadsheet, and
- Qualitative trends and relationship between the variables represented.

Technical Objectives:

- Build an ontology of charts and graphs that can be used by a knowledge based system to control the application of document and image analysis algorithms to analyze their images
- Identify independent and dependent variables in the figure, using a combination of document image analysis and common sense reasoning
- Identify key word representations of the information in charts and graphs using computer vision and common sense reasoning, that can be queried by a general search engine to support a graph/chart search capability
- Develop a deeper representation that can be used to answer content-based queries about retrieved graphs or small collection of graphs.
- Develop methods that detect duplicate charts and graphs based on their information content.

Goals:
The goal of this research project is to combine technologies from image processing (two-dimensional shape analysis, document analysis, etc) and artificial intelligence (knowledge management, common sense reasoning, etc) to construct a computer system that can build symbolic representations of charts and graphs from their images, answer simple questions about the information contained in those figures, and detect duplicates for efficient use of human resources.

10. Advanced Methods to Improve Automated Speaker Identification

Questions on Topic 10 can be e-mailed to: topic10@icpostdoc.org

Proposed Research Project:
The goal of this proposal is to significantly improve the performance of automated speaker identification when a live speaker is being compared to speech samples previously recorded via a different communications channel. The approach will involve the analysis a speaker's word choice, prosody, and other higher level cues in combination with conventional acoustic speaker recognition approaches, such as the well-known Gaussian Mixture Model. "Channel mismatch" is one of the most significant challenges to overcome during the general application of speaker identification and thus techniques to improve recognition that are channel independent will impact match performance greatly. Use of higher level features will also contribute to the related field of automatic speech recognition, because accurate recognition of speech will improve "speaker modeling" that is, using models that are more closely tuned to the talker. Another closely related field, speaker diarization ("who spoke when"), will benefit from the use of higher level features which could lead to improved speaker tagging of audio streams containing multiparty speech, such as network news, talk shows, and teleconferences, and facilitating audio mining within vast archives of recorded meetings, audio broadcasts, phone messages, etc.

Technical Objectives:
- To study the robustness of various acoustic and high-level features when applied to the analysis of speaker database collected using multiple channels
- The implementation of a system that closely integrates the use of acoustics, word choice, prosody, and other high-level cues
- Investigation of the best way to combine the sources of information conditioned on both the acoustic conditions and the presence of higher level features.

Goals:
The goal is to increase our fundamental understanding regarding better ways to utilize the wide range of speech attributes used by humans. Improve the performance of automatic speaker identification systems in the presence of channel mismatch

11. Applied Development of Active Imaging Systems

Questions on Topic 11 can be e-mailed to: topic11@icpostdoc.org

Proposed Research Project:
The integration of active optical elements can potentially reduce the size, weight, and power requirements of conventional imaging systems. At the same time, active imaging systems may provide increased flexibility and capability compared to their conventional counterparts. Historically, active elements such as deformable mirrors (DMs) have been used to remove atmospheric turbulence for astronomical imaging and liquid crystal (LC) spatial light modulators (SLMs) have been used to correct intracavity aberrations in high-power laser systems.

As active optical devices improve in dynamic range, resolution, and aperture size, the potential applications for these devices grows tremendously. Active imaging systems have already been proposed for satellites, UAVs, unattended ground sensors, and even cell phone cameras.

Technical Objectives:
- Novel integration of active optics into various imaging system to improve performance.
- Improve the performance of optical devices (e.g. MEMS mirrors or LC spatial light modulators).

Goals:
This topic will investigate the science leading to novel ways to construct active image systems that are more stable, mechanically robust, and provide new imaging capabilities.

12. Streamlining Global Pandemic Monitoring via Convergence of Hardware and Software for Multilingual Data Processing

Questions on Topic 12 can be e-mailed to: topic12@icpostdoc.org

Proposed Research Project:
The goal of this proposal is to identify and possibly prototype innovative methods for integrating hardware and software for Natural Language Processing (NLP) to enhance monitoring of huge volumes of indigenous multilingual data sources (broadcasts, webcasts, public health/medical, intelligence, and so forth), and directly and/or remotely engage foreign representatives in the monitoring of and response to global pandemics. This could include interactions with the ongoing Argus Global Pandemic Monitoring program as well as other efforts.

Technical Objectives:

- Identify Challenges – Key challenges lie in finding innovative ways to quickly deal with huge volumes of multilingual data effectively. The postdoctoral researcher must identify methods to bridge capabilities across computational linguistics, molecular genetics, statistics, and electrical engineering disciplines to affect a convergence of H/W and S/W to solve urgent pandemic issues such as Avian flu.
- Assess opportunities for collaboration with Argus Global project participants: sponsors (ITIC and the U. S. Army Medical Research and Material Command); partners and collaborators (MITRE's Multi-Center Team and Georgetown University); and key stakeholders (IC, DHS/NBIS, DOD COMs & Armed Forces Medical Intelligence Center, HHS, and DOS) dealing with global pandemic monitoring and response to identify NLP challenges.
- Research Innovative Solution Sets – Research integrated hardware and software NLP methods to address challenges. Research could include investigations of hardware and tools, such as, Field Programmable Gate Arrays (FPGA), machine translation engines, cross-language information retrieval, data mining, summarization algorithms, and Weka (a collection of machine learning algorithms) to quickly analyze data points in large volumes of Romance and non-Romance languages.
- Prototype Methods – If possible, prototype integrated hardware and software NLP methods.

Goals:
Possible outcomes from this research include a white paper or thesis describing the research in this area, and possibly prototypes that could be transitioned to Argus Global and/or other global pandemic monitoring and response systems and activities.

13. Methods and Techniques for Training Intelligence Professionals to Perform Scientific and Technical Intelligence (S&TI) Analysis While Applying Denial and Deception Tradecraft to Their Analytic Process

Questions on Topic 13 can be e-mailed to: topic13@icpostdoc.org

Proposed Research Project:
The goal of this proposal is to advance technical intelligence by developing new, more effective training methodologies that include denial and deception tradecraft as an integral part of the training. Denial and deception in this context refers primarily to the use of camouflage, concealment, and deception materials and techniques, but could extend into the discipline of perception management. Possible research should include an examination and extension of the ideas and strategies from the fields of technical and higher education. Denial and deception practices intentionally create a knowledge space designed to support a solution space orthogonal to the real solution space. Thus, the problem becomes knowing that there is a problem with the knowledge space. Hence, advanced heuristic solution concepts and cognitive learning theory need to be examined to discover new methods and techniques for training intelligence professional to recognize and defeat denial and deception practices.

Technical Objectives:

- Content – Identify the cause(s) of unsuccessful analysis (to include denial and deception) and determine the knowledge, skills, and abilities analysts need to succeed. Consider the importance of the cognitive and perceptive dimensions of intelligence analysis.
- Materials – Discover innovative and effective tools for teaching analysts how to approach problems that involve a high degree of uncertainty and misdirection. This may involve research in human factors, heuristics, and industrial and cognitive psychology.
- Presentation – Discover optimal methods for presenting the materials and teaching intelligence trainees. This may involve research into computer-based training concepts, team-oriented learning, and the effects of prior training, education, and environmental factors.

Goals:
Anticipated outcomes from this research are a white paper or thesis describing the research in these areas. The goal is to describe the practical application of the results in the form of a syllabus and manual of instruction. The emphasis will be on the "who, what and how" of instruction into the methods of dealing with ambiguous and fragmentary (intelligence) data in a "low-signal-to-noise" environment.

14. Effects of Humidity on Atmospheric Transmission for Infrared Sensors

Questions on Topic 14 can be e-mailed to: topic14@icpostdoc.org

Proposed Research Project:
Effects of Humidity on Atmospheric Transmission for Infrared Sensors

NGA/IJ has noticed in its airborne IR Hyperspectral data collections and in its ground based IR data collections a tendency for increased errors and variability on humid days. The spectral data indicates that the atmosphere can become quite emissive/absorptive over most of the IR spectral region thus negating the reasonably good transmission one expects in the "atmospheric window" regions. The standard atmospheric compensation routines in use today are not fully correcting for some, as yet not understood, atmospheric phenomena associated with humid conditions that affect the IR portion of the spectrum.

NGA is concerned that this effect if not better understood, could impair planned future spectral collection programs. NGA has hope that there might be some predictability to the phenomena wherein precious and costly collection opportunities would not be wasted.

Technical Objectives:
To improve understanding, verify that effect by utilizing the very large infrared data set taken by a joint NOAA/University of Miami program collected with a 1 cm-1 resolution spectrometer over 5+ years. The IR sensor is located about 60m above the sea surface so should not be affected by local sea spray. By marrying the weather data and the 1cm-1 resolution IR data some correlation between humidity and IR atmospheric effects should be noted and this should provide an empirical basis for a predictive atmospheric transmission vs. humidity model. Perhaps there are other data sets that could be used as well to span the humidity conditions that cause the transmission degradations.

A second part of this effort concerns NGA's IR spectral sensor processing programs, which currently assume that the atmospheric transmission is about the same throughout a whole image frame. Some recent data indicates that this may not be true. Careful examination of this NOAA/U.of Miami data set (or other sets spanning time & space) should provide some indication of the scale sizes of atmospheric transmission variability. This is an important quantity to know and may require the future development of new small-scale atmospheric compensation routines.

Goals:
The goal of this effort is to utilize the very large infrared data sets taken from the Explorer of the Seas ARM facility to examine how humidity effects atmospheric transmission and what might be the scale size and formation conditions of such an effect. It also has a secondary goal of providing a better understanding of the cirrus effects on atmospheric sensing and how such effects might be better predicted.

15. Modeling the Behavior of Very Small Water Droplets in the Atmosphere

Questions on Topic 15 can be e-mailed to: topic15@icpostdoc.org

Proposed Research Project:
Develop a theoretical model to predict the occurrence and behavior of very small (<100nm) water droplets in the atmosphere as a function of humidity. This work would provide an understanding of the formation and size development of such particles and their expected concentrations. Furthermore, this work would provide an understanding of how their occurrence might be predicted from weather models and satellite data, such as the NOAA GOES sensors, and how these particles might affect electrical optical sensors.

Technical Objectives:
Since the 1970's small water particles have been measured by mass spectrometers in the atmosphere by what used to be AFGL at Hanscom AFB, MA. Recent NGA ground- and air-based hyperspectral IR measurements have been dominated by a gray-body-like emission from the atmosphere—strongly suspected to be droplets of liquid water that are too small to scatter visible light. NGA has a need to (1) understand the conditions under which these particles form, and (2) predict their occurrence world-wide. This work will seek to develop a theoretical model to predict the occurrence and behavior of very small (<100nm) water droplets in the atmosphere as a function of humidity. This work would provide an understanding of the formation and size development of such particles, their expected concentrations, and how their occurrence might be predicted from weather models and NOAA GOES data.

Goals:
The first goal of this project is to predict the occurrence and behavior of very small (<100nm) water droplets in the atmosphere as a function of humidity using weather model output and the world-wide, GOES-like satellite data. The second goal is to understand and predict the effects of these water droplets on electrical optical sensors in humid environments. One topic of interest is how small-scale variations of droplet concentrations might impose limits to sensing accuracy

16. Audio Collection and Processing

Questions on Topic 16 can be e-mailed to: topic16@icpostdoc.org

Proposed Research Project:
The goal of this project is to develop improved speech and acoustic event recognition specifically for audio collection applications. Methods of detecting speech in noise, mitigation of noise, exploitation of biological effects, and acoustic event detection are of particular interest as they apply to audio collection.

Technical Objectives:

- Detection of Voice in Noise: better methods to detect voice in the presence of noise such as engines, fans, music, etc., and the ability to identify a specific individual from voice in noisy environments are of interest. Audio can be analyzed after collection to detect voice activity, or methods can be devised to ensure that only voice is collected. Translators/transcribers can be more effective if we can reduce the amount of irrelevant information that they must review.
- Key Acoustic Event Detection. Spotting key acoustic events is useful in extracting information from long or multiple audio recordings, and it is also helpful in triggering a recording event. For example, an opening door can be used as part of a data reduction effort through event detection.
- Intelligibility of Speech: We are interested in the problem of sorting through audio to determine if the content is worthwhile. This does not imply translating all collected audio, but rather the prioritization of large amounts of collected audio by identifying key words and utterances. An understanding of how speech intelligibility is affected by environmental and electronic constraints may enable better designs that provide audio that is more readily prioritized and transcribed.

Goals:
The goal of this work is to develop tools that will allow the vast amounts of audio to be processed and reviewed for content prior to analysis. This will enable the analysts to prioritize the collected audio and review only the information that is relevant. Also, other useful tools can be created through this research such as voice-activation systems (VOX), which allow audio collection equipment to only record when someone (or a specific individual) is speaking.

17. Enabling Technologies for Robotics

Questions on Topic 17 can be e-mailed to: topic17@icpostdoc.org

Proposed Research Objectives:
Research into three enabling technologies for small ground mobile robotics: modeling and simulation of small (kg-sized) robots in contact with ground and compliant obstacles; improved actuators for the mesoscale; and teleoperation.

Under an existing ITIC program, we have been systematically selecting Post Docs in areas of robotics that we believe:

- require long term basic research and,
- Are necessary for us to understand internally at more than a superficial level.

Technical Objectives:
Modeling and Simulation techniques that help to answer the general question: "Can a given robot traverse a given terrain?" Issues such as ground-robot interaction and characterization of deformable terrain are of particular interest. Develop first principles models of ground/robot contact on terrestrial materials (soils, rock, and vegetation) that can be used to more effectively design mobile robots and predict their performance

Efficient, linear actuators with exceptional power, stroke and bandwidth characteristics in small form factors appropriate for snake and other mesoscale robots. In particular, connectors must be addressed.

Development of system design technology that incorporates human cognition as a system component for remote multi-level supervisory control of robots interacting with the world. Lower-level autonomous functions (a snake interacting with affordances, for example) are of greater interest than higher=level functions (path planning for example).

Goals:
The proposed work continues to reinforce the original goals of the effort:

- To create a small, but integrated, group of young professors and lab technical staff that are familiar with our interest in robotics and know some of our officers, and
- To create a group of officers within the community who have some familiarity with the problems of robotics and know some of the researchers who work in relevant areas.

18. Efficacy of Automated Text Analysis in Differentiating Between True and False Witness Statements

Questions on Topic 18 can be e-mailed to: topic18@icpostdoc.org

Proposed Research Project:
The goal of this project is to evaluate the accuracy of automated text analysis programs in distinguishing between true and false witness statements provided by individuals claiming to have knowledge of events of interest to U.S. officials.

Experience in the collection of data within a field environment is highly recommended.

Technical Objectives:
The technical goals of this project are to use 3 currently available language analysis programs to: a) characterize true eyewitness accounts provided by U.S. military special operations teams; b) characterize false eyewitness accounts provided by U.S. military special operations teams; c) determine the sensitivity and specificity of these 3 systems in differentiating false from true eyewitness accounts.

Goals:
Possible outcomes from this research include a white paper or thesis describing the research in these areas. It also could describe (if the current methods prove less than effective) new directions in language analysis programs designed to distinguish true from false accounts. The practical application of the results in the form of a syllabus and manual of instruction and an automated software program for use on statements collected from people. The emphasis will be on the "who, what and how" of instruction so that the methodology can be applied to specific intelligence disciplines in a consistent fashion.

19. Algorithms for Quantum Computation

Questions on Topic 19 can be e-mailed to: topic19@icpostdoc.org

Proposed Research Project:
This topic call is for a theoretical exploration of quantum mathematics toward solutions to classically hard problems in NP (e.g., 3-SAT, KNAPSACK, etc.)

Technical Objectives:

- Discovery of quantum algorithms beyond Shor, Grover, Hallgren, QFT, and Adiabaticity.
- Mapping of the solution space of such algorithms into NP-class hard problems.

Goal:
The shaping and elucidation of a quantum computation algorithm or algorithms beyond the current set found in the open literature which has no analog solution in the classical computation domain.

20. Architectures for Scalable and Secure Quantum Communications

Questions on Topic 20 can be e-mailed to: topic20@icpostdoc.org

Proposed research Project:
This topic call is for a foray into the world of quantum communications for the purpose of crafting a secure and scalable architecture.

Technical Objectives:

- A quantum entanglement-based communication protocol that is cryptographically secure and functionally scalable to tens and hundreds of network nodes.
- Instantiation of this protocol in an architecture which functions beyond the unicast systems of BB84 and B92 quantum cryptographic protocols into one of a multicast paradigm.

Goal:
Next generation quantum communication system for secure key distribution and/or one-time pad encryption functionality.

21. Edge Supercomputing Architectures via Commodity Graphics Processing Units

Questions on Topic 21 can be e-mailed to: topic21@icpostdoc.org

Proposed Research Project:
An investigation into petaflop (and up to Exaflop) HEC architectures using commodity GPUs.

Technical Objectives:

- Design and implement a petaflop GPU-based HEC with significant edge computational power.
- Incorporate programmability and utilization considerations into this architecture design.

Goals:

- HEC edge-based architectures consisting of GPU commodity chips.
- Scientific estimation of the scale and power requirements of such architectures.
- LINPACK performance capabilities on par with multiple-orders of magnitude cost and scale systems.

22. Enhanced Resolution Integrated Digital Super-Resolution Imaging Systems

Questions on Topic 22 can be e-mailed to: topic22@icpostdoc.org

Proposed Research Project:
This topic call is for a practical, enhanced resolution, integrated optical-digital imaging system.

Technical Objectives:

- An information theoretic framework based upon Fisher information as objective criteria for multi-channel and diffractive optics-based imaging system performance.
- A multi-channel lenslet array thin camera system based on diffractive optics elements and/or optical wavefront coding capable of realizing resolution beyond the diffraction limit (digital super-resolution), something not previously thought possible.

Goals:

- An objective information theoretic construct around integrated digital optical imaging systems which can be
- An end-to-end integrated optical-digital camera system that is an order of magnitude in dimension and weight reduction while outperforming classical common optics-based imaging systems.

23. High Productivity Computing Systems (HPCS) Software for Independent, Maximal Platform Utilization

Questions on Topic 23 can be e-mailed to: topic23@icpostdoc.org

Proposed Research Project:
The investigation and realization of HPCS languages which maximize software productivity and HEC machine utilization independently from vendor platform.

Technical Objectives:

- Realization of high productivity software programmability suite which is independent from HEC vendor platform, is easily extensible, and maximally utilizes available machine cycles.
- Implementation of this software suite among leading HEC vendor platforms with utilization metrics exceeding 90 percent.

Goals:
Platform-independent software interface and design suite for HEC systems.

24. Spatial-Temporal Visualization of Antigenic Drift and/or Antigenic Shift in Avian Influenza Virus

Questions on Topic 24 can be e-mailed to: topic24@icpostdoc.org

Proposed Research Project:
The endemic baseline of H5N1 Avian Influenza virus in domestic and wild birds is unknown despite the existence of data throughout the world. Little is known how the AI virus has changed genetically over space and time, and what changes at the genomic level are expressed as antigenic drift/shift toward human-to-human transmission.

An understanding of temporal-spatial changes in avian influenza genome sequences is a fundamental prerequisite in AI surveillance and modeling systems. These systems need to project rates of global movement of AI strains to anticipate new strains for use in vaccines, to predict when and where new strains will emerge and spread, and to identify anomalous or unpredicted strains. AI surveillance systems and models must be able to address how the virus genome changes over time and from one geographic region to another. Efforts to incorporate molecular information about AI into surveillance systems and models will require a rigorous and complete assessment of the literature pertaining to known strains of AI reported worldwide, as well as knowledge of the forces that influence nucleic and amino acid sequence changes resulting in antigenic drift and/or shift and development of new strains. Temporal and geographical changes in the molecular make-up of AI must be incorporated into models developed to project when and where new strains will appear, the nature of the change (site and impact of sequence changes expected), and factors that may explain why the changes occurred. This fellowship may require a security clearance.

Technical Objectives:
- Identify the location of avian influenza outbreaks in domestic and wild birds/other animals since January 1997; the focus will be on subtypes known to be pathogenic for humans
- Acquire the associated epidemiologic and phenotypic data associated with the outbreaks due to high and low pathogenicity strains of avian influenza virus
- Acquire existing genomic sequence data on high and low pathogenicity strains of avian influenza virus
- Perform bioinformatic and comparative genomic analyses of the genomic data to determine which gene(s) may be associated with antigenic drift/shift
- Integrate data into AI spatial-temporal model at the Armed Forces Medical Intelligence Center

Goals:
Spatial-temporal visualization of antigenic drift and/or antigenic shift in avian influenza virus that may be associated with human-to-human transmission

25. Cavity-Based Single Indistinguishable Photon Sources

Questions on Topic 25 can be e-mailed to: topic25@icpostdoc.org

Proposed Research Project:
The goal of this fellowship is to advance the state of science in single photon sources (SPS's) at visible to near infrared wavelengths used for telecom applications. An ideal SPS would produce exactly one photon per pulse on demand. There are several proposed techniques for constructing at least a good approximation to such an ideal SPS. One promising class of techniques relies on exciting a single quantum emitter in a high-Q cavity. Examples of this approach currently under investigation include a quantum dot (QD) in a photonic crystal (PC) or microdisk cavity, and a high-Q cavity containing a single ion, neutral atom, or diamond crystal nitrogen vacancy. Further research in these areas is of interest, but novel approaches are also welcome and invited. This research seeks to achieve marked advances in speed, single photon probability, wide operating wavelength, and productiveness of the source.

Technical Objectives:
The objectives for research under this fellowship are to produce a prototype single photon source (SPS) with the following quantitative performance measures:

- Photon rate: > 10 MHz out of the fiber (fiber coupled source) or exit aperture (free space source)
- Multi-photon probability suppression: $g^{(2)}(0) < 2\%$
- Photon indistinguishability: $I > 90\%$
- Operating wavelength: Principal current interest is in wavelengths around 780 nm for free space operation (coincident with the maximum product of detector efficiency and atmospheric transmission for Si-APDs). However, as new detector technologies become available that permit operation closer to more favorable atmospheric wavelengths near 1500 nm, sources at that wavelength will be useful. For fiber operation, values of 1310 nm (preferred) and 1550 nm are of interest. Ideally, the source technology would be tunable, or at least adaptable, over some significant range.
- Operating temperature: A path to operation with thermoelectric cooling (i.e., no cryogenic liquids) is preferred.

Goals:

- Demonstrate a prototype device capable of producing single photons on demand while meeting the technical objectives listed above.
- Single photon sources with the stated performance measures would have ubiquitous applications in quantum information science research and applications. Therefore, it is important that the proposed source architectures be suitable for automated production and turnkey operation as the technology matures. A second goal of this work will be to elucidate that path to practical fabrication.
- Publish at least two papers in peer reviewed technical journals such as *Applied Physics Letters*, *Physical Review A*, *Journal of the Optical Society of America B*, etc.

26. Entangled Photon Sources

Questions on Topic 26 can be e-mailed to: topic26@icpostdoc.org

For this topic the IC Postdoctoral Research Fellowship Program encourages a consortium between academia and industry.

Proposed Research Project:
Research Proposals concerning pulsed, fast sources of entangled photons, at visible to telecom wavelengths will be considered.

Technical Objectives:
- 10+ MHz,
- 780nm,
- 1310 nm… see chart on page 33.

Goals:
Goals and specifications of entangled photon sources for quantum key distribution
There are primarily two methods for Quantum Key Distribution (QKD):
- Free space optical QKD
  To develop a compact, narrowband, pulsed source of polarization-entangled photon pairs suitable for through-the-air optical QKD at a wavelength that optimizes the key generation rate using Si single-photon detectors. To ensure source technology is scalable to higher generation rates for future applications
- Fiber optic QKD.
  To develop a compact, narrowband, pulsed source of time-bin entangled photon pairs suitable for fiber optical QKD at telecom wavelengths that optimizes the key generation rate. To ensure source technology is scalable to higher generation rates for future applications.

Free space QKD is closer to practical realization because of favorable development in entanglement sources and single-photon detectors.
Fiber optic QKD development is hampered somewhat by the lack of reliable detectors.

Entanglement source specifications	**Free-space QKD**	**Fiber-optic QKD**
Generation rate	10^5 pairs of polarization-entangled photons per second	10^5 pairs of polarization-entangled photons per second
Wavelength	~780 nm	~1310 nm (degenerate); ~1310 nm and 600-800 nm (nondegenerate)
Wavelength stability	± 0.025 nm	± 0.25 nm
Optical bandwidth	0.1 nm	1 nm
Entanglement state	A definite Bell state with 98% fidelity	A definite Bell state with 98% fidelity
Timing constraints	Periodic generation to allow synchronization of detection circuitry	Periodic generation to allow synchronization of detection circuitry
Timing window	< 1 ns; timing jitter < 100 ps	< 1 ns; timing jitter < 100 ps
Spatial mode	Few spatial modes, fiber coupled is desirable	Single spatial mode, fiber coupled for the 1310-nm photons; few spatial modes for the 600-800 nm photons, single-mode fiber coupling is desirable
Size and packaging	Rack mountable, turnkey operation	Rack mountable, turnkey operation

Pump source specifications	**Free-space QKD**	**Fiber-optic QKD**
Wavelength	~390 nm	dependent on wavelength range of entanglement source
Wavelength stability	± 0.01 nm	± 0.1 nm
Bandwidth	≤ 0.05 nm	≤ 0.5 nm
Pulse duration	≤ 100 ps	≤ 100 ps
Repetition rate	10 - 100 MHz	10 - 100 MHz
Timing jitter	≤ 1 ps	≤ 1 ps
Synchronization	Capable of being synchronized to an external clock	Capable of being synchronized to an external clock
Power	0.2 W average power in a TEM_{00} spatial mode	~0.2 W average power in a TEM_{00} spatial mode
Size and packaging	Rack mountable, turnkey operation	Rack mountable, turnkey operation

27. Single Photon Detectors

Questions on Topic 27 can be e-mailed to: topic27@icpostdoc.org

Proposed Research Project:
The goal of this fellowship is to advance the state of science in single photon optical and near-infrared detectors. Current research in this area includes detector constructions employing Quantum Dot Gated Field Effect Transistors (QDOGFET), Avalanche Photodiodes (APD), Superconducting Transition Edge Sensors (TES), and wavelength conversion schemes. Further research in these areas is of interest, but novel approaches are also welcome and invited. Marked advances are sought in speed, quantum efficiency, reduced dark counts, wide operating wavelength, and temperature of operation.

Technical Objectives:
The objectives for research under this fellowship are to produce a prototype detector with the following quantitative performance measures:

- Count rate: > 10 MHz
- Absolute quantum efficiency: > 90%
- Noise and dark counts: < 1 kHz
- Operating wavelength: Principal current interest is in wavelengths around 780 nm for free space operation (coincident with the maximum product of detector efficiency and atmospheric transmission for Si-APDs). However, new detector technologies may permit operation closer to more favorable atmospheric wavelengths near 1500 nm. Values of 1310 (preferred) and 1550 nm are of interest for fiber operation. Ideally, the detector technology would be tunable over some significant range.
- Operating temperature: A path to operation with thermoelectric cooling (i.e., no cryogenic liquids) is preferred.

Goals:

- Demonstrate a prototype device that achieves single photon detection while meeting the technical objectives listed above.
- Single photon detectors with the stated performance measures would have ubiquitous applications in quantum information science research and applications. Therefore, it is important that proposed detector architectures be suitable for automated production and turnkey operation as the technology matures. A second goal of this work will be to elucidate that path to practical fabrication.
- Publish at least two papers in peer reviewed technical journals such as *Applied Physics Letters*, *Physical Review A*, *Journal of the Optical Society of America B*, etc.

28. Integrated System of Systems Analysis (SOSA) for Intelligence Modeling of Physical and Non-Physical Networks

Questions on Topic 28 can be e-mailed to: topic28@icpostdoc.org

Proposed Research Project:
Major changes in the strategic environment and evolving operational requirements have significantly altered the demand for an increased breadth and granularity of intelligence information requirements. These changes have also reduced the timeframe in which analytical assessments/targeting recommendations must be developed and disseminated in order to be relevant and actionable.

Because the consequences of our actions ripple beyond the adversary's military into its political, economic, cultural, social, religious, etc., dimensions, an approach that considers the full scope of the environment is needed for system-of-systems analysis (SOSA) of physical and non-physical infrastructure networks. Physical networks include electric power (EP), telecommunications (TELECOM), transportation/logistics (TRANSLOG) and petroleum, oil, lubricant (POL). Non-physical networks include political, economic, social and financial networks. All of these systems are inter-related to some degree, where the failure or degradation of one network can produce cascading failure or degradation in one or more inter-related networks.

There are several modeling approaches that attempt to capture functional details of each individual network, but there has not been an approach that has yielded a comprehensive understanding of the 2nd and 3rd order effects of the inter-relationship of more than two networks. Complicating factors include estimation error and data sparseness that cause uncertainty in the individual networks and in the characterization of the intersections among them. There are several organizations within the DoD, DoE, and IC Community that are working aspects of these problems. DIA is currently pursuing an analytical Modeling and Simulation (M&S) tool suite capability to perform complex system-of-systems analysis of physical infrastructure (EP, TRANSLOG, TELECOM, and POL) and model interconnectivity of these networks to capture 2nd and 3rd order effects.

The Research Fellow will prepare a multidisciplinary survey of literature on infrastructure modeling methodologies, system-of-systems modeling methodologies, including current initiatives, and produce a planning document that addresses integrated SOSA capabilities across the Intelligence Community. Research should include, but not be limited to:

- Surveying systems-of-systems programs for physical and nonphysical infrastructure analysis in academia (i.e., Purdue, University of Missouri-Rolla, etc.), industry and government.

- Prototyping activities that model:
  - Physical systems and their characteristics from the behavioral perspective.
  - Inter-relationships among systems.

  - Uncertainty (e.g., demonstrating how to identify it, measure it and estimate the model's sensitivity to it.

- Determining the best means (i.e., best balance between efficient/effective) of achieving a systems-of-systems analytic capability.

Technical Objective:

- Identify and propose a commercial off-the-shelf, government-off-the-shelf, or reasonably mature environment for studying, modeling, and simulating networks as described above.
- Demonstrate the "best means" analytic capability (as described in the preceding paragraph) by incorporating multiple physical and non-physical networks (e.g., EP, POL, LOC, TELECOM, Political, Military, Social, Informational, and Finance) into a system-of-systems model. These objectives will be achieved with the assistance of the IC advisor and the team currently working to operationalize SOSA tools for the DIA.

Goals:

The overall goal of this effort is to improve the Intelligence Community's ability to provide policymakers and warfighters comprehensive holistic system of systems analysis that identify capabilities and vulnerabilities within and among the aggregate systems and provide the full range of options with which to exploit them. Specifically, the research will:

- Determine an approach for integration of analytical and scientific means for determining cross-infrastructure dependencies.
- Determine a methodology of validating and verifying the integration of physical and non-physical infrastructure networks.
- Determine research and development gaps and mitigation strategies for the SOSA process.

29. Uncertainty Challenge in Modeling Intelligence Problems

Questions on Topic 29 can be e-mailed to: topic29@icpostdoc.org

Proposed Research Project:
Intelligence professionals are turning to modeling and simulation capabilities to support analyses (and collection strategies) that are more predictive in nature and that explore both intended and unintended consequences of a particular course of action. Modeling and simulation capabilities enable intelligence analysts to better understand and explain how causes translate into effects. However, intelligence data required for modeling and simulation are rarely complete, and intelligence professionals must clearly state how this uncertainty in the available data limits our ability to predict.

Uncertainties in intelligence models may result in critically different outcomes. Intelligence data uncertainty arises from data gaps, as well as from unreliable data. There are system unknowns, which are things we know we don't know as well as things we don't know we don't know. There is also inherent randomness, which is defined as things that vary day to day. Each of these different types of uncertainties must be taken into account.

Uncertainty can be addressed by using agent-based and rules-based models. These models capitalize on intelligence analysts' domain expertise to create and vary rule sets adapted to situations in foreign countries. Such rule sets can be modified to account for robustness or gaps in the available data. Although there exist many commercial and government models that were created for domestic planning purposes, these models assume a full and complete data set. Also, using Western standards for simulation rule sets can create flawed results when applied to foreign country networks that were not constructed by, and do not behave according to, Western standards. However, an understanding of the current state of the art for predicting "cause and effect" in domestic (U.S.) system of systems models created with more complete data may contribute to understanding models used in the intelligence community that are subject to greater uncertainty.

Given the unknowns and inherent randomness in the systems being modeled, how much confidence should we have in the model results? Some level of uncertainty can usually be tolerated before the results lose meaning, how do we characterize this threshold? The problem may be approached from multiple directions. One approach might be to validate courses of action over a set of various networks that is "sufficiently large" to yield statistically significant confidence levels. Effects of inherent randomness in the data may be revealed by such statistical techniques. Another approach might be to use analyst subject area knowledge to validate the results based on expertise and intuition. Effects of system unknowns in the data may be readily apparent to the experienced analyst. Most likely, a combination of these and other approaches will help us ascertain the level of confidence we should have in the results given the uncertainties inherent in the systems being modeled.

The research proposal should address the following issues in regard to modeling uncertain data: How can intelligence professionals portray the results to customers?; What do customers need to

know about the models, the data modeled, and gaps or randomness in the data modeled to still have confidence in the model outcome?; How should each model be examined to determine which data are most critical to a consistently successful result?; How do we deal with one model's dependence on other models for data input?; and, What is an appropriate method for dealing with uncertainty in system-of-systems models that look at dependencies and vulnerabilities across multiple networks, particularly when each individual network may have been constructed from an incomplete data set?

Technical Objectives:
The current baseline simulation environment demonstrates very promising results as an important tool for cross-functional analyses; however, additional research is required to expand cross-functional analyses to reach the more holistic project goals. As such, the primary objectives of the proposed work are:

- To research and develop methodologies that properly account for the impact of missing and /or unreliable data on the predictive efficacy of the (se) models.
- To research and develop methodologies that quantify confidence levels associated with cross-functional simulation outcomes.
- To research and develop methodologies directed at the inclusion of human/social behavioral characteristics as well as socioeconomic influences on/of system failures.

Goals:
The ultimate goal of this research proposal is to model uncertainty to the extent that analysts can confidently produce assessments that respond to the National Security Strategy demands for faster, integrated, and more prescriptive intelligence to anticipate and respond to the new threat environment.

30. Ultra-precision Digital Exploitation of Imagery Data for Automated Object Detection, Location, and Tracking

Questions on Topic 30 can be e-mailed to: topic30@icpostdoc.org

Proposed Research Project:
The goal of this proposal is to advance the state-of-the-art in quantitative, digital imagery exploitation based on transitioning algorithms and tools used successfully in astronomy to detect anomalies, weak sources, and source dynamics (movement, change).

Technical Objectives:

- Data fidelity requirements assessment
- Algorithm evaluation with various data types (airborne video, space imagery sequences, and radar products from airborne systems).
- Identification of desired algorithm extensions for IC applications

Goals:
Current state-of-practice with commercial products provides motion compensation for airborne video at the single pixel equivalent resolution level, compensating for DTED 0-1 elevation variations. Developmental work at government labs is intended to improve this performance to the 0.5 pixel geo-registration and ortho-rectification regime and to either detect/track movers or to compensate for parallax effects. Under the Pan-STARRS program (see http://pan-starrs.ifa.hawaii.edu/public/), the astronomical community is aimed at the 0.1-0.2 pixel image co-registration level, correcting both spatial and radiometric data, to provide the precision images best suited to automated change detection with minimal false alarms. The goal of this IC post-doc project is to see how well these higher precision astronomical approaches can be adapted to selected datasets and sensor systems. The compiled evaluations and assessments will be made available to the appropriate IC and DOD space and airborne programs.

31. Sparse-Aperture Telescope Studies

Questions on Topic 31 can be e-mailed to: topic31@icpostdoc.org

Proposed Research Project:
The goal of this proposal is to advance the technical capabilities and cost-effectiveness of future reconnaissance systems by (1) developing an understanding of sparse-aperture telescope system trade-offs, and (2) evaluating how sparse-aperture systems would perform as panchromatic or multispectral imagers.

Technical Objectives:

- Fourier modeling at the level of Fourier Optics (Goodman) to compare and contrast the optical performance of various sparse-aperture concepts, to include
  - Segmented primary aperture systems, e.g. The Keck Telescope
  - Multi-telescope systems, e.g. the original Multiple Mirror Telescope
  - Synthesized aperture concepts
  - Pupil plane or "Fly Eye" concepts
  - Formation flying concepts
- Physical optics modeling of aberrations at the level of Principles of Optics (Born and Wolf)
- Development of image quality equations for selected multi-aperture system concepts relating product resolution and quality measures to system parameters and collection scenarios.
- Identifying how selected concepts could be augmented to function as imaging spectrometer systems.

Goals:
For predicting the performance of sparse-aperture systems as panchromatic imagers, the goal will be to determine the system spatial resolution and image quality. Quality will be determined through the National Imagery Interpretability Rating Scale or NIIRS equations (ASPRA/ASCM Annual Convention and Exhibition Technical Papers: Remote Sensing and Photogrammetry, Vol. 1, pp. 262-272, 1996) as a function of parameters of the system (aperture diameter, configuration, fill fraction, aberration levels, optical bandwidth, and optical throughput) and scenario (distance to target, sun angle, and atmospheric conditions).

For selected sparse-aperture system concepts, the researcher will identify spectrometer subsystem concepts and analytic methods for estimating the scene spectrum for each pixel. In addition, the researcher will use information-theoretic approaches to determine the best spectra achievable for each concept at a given level of noise and frame integration. Finally, the researcher will specify system parameters needed to adequately perform spectral sensing tasks.

32. Quantum and Nanotechnology for Enhanced Sensing Capabilities

Questions on Topic 32 can be e-mailed to: topic32@icpostdoc.org

Proposed Research Project:

Recent developments in quantum-dot, quantum-well, and photonic-bandgap technology have led to some very encouraging results in laser source and infrared sensor technology. Significant improvements in laser efficiency as well as improved detectivity and higher temperature operation for infrared photodetectors have been demonstrated. These encouraging results suggest that it is time to push the state of understanding over the next two years, at which point it will be possible to develop plans for transition of the technology to practical implementation.

Areas of interest include:

- High power Quantum cascade Lasers (QCLs) for remote sensing
- Advanced mid-and long-wavelength infra-red photodetectors

Technical Objectives:

- High Power Quantum Cascade Lasers (QCLs) for Remote Sensing
  Depending on the application chosen, the following are offered as suggested areas of further research:
  - General: Improve QCL efficiency and demonstrate continuous output power greater than 1 Watt per diode at room temperature
  - Free-Space Communications: Modify high power technology to allow for high speed modulation up to 1Gbps
  - Remote Chemical Sensing/Chemical Spectroscopy: Modify high power technology to exhibit narrow-linewidth emission and wide tenability
  - Infrared Countermeasures: Develop QCL array technology to demonstrate greater than 10 Watt power at room temperature.

- Advanced Mid and Long-Wavelength Infra-Red Photodetectors

The primary objective of this proposed effort is to demonstrate high performance two-color detection of MWIR and LWIR radiation using Type II superlattice material systems. Specifically, it is desired to demonstrate higher device quantum efficiency (QE) and specific detectivity (D*) at higher operating temperatures than those presently achievable using present day HgCdTe technology. It is recommended that Molecular Beam Epitaxy (MBE) methods, optimized for low defect density and high uniformity be considered for material growth, and that all device surface passivation be accomplished using well established compound semiconductor processing techniques.

Goals:

At present, continuous wave operation has been demonstrated from 4-9.5μm. However, there are few groups capable of demonstrating high power QCLs. Though power levels are promising at isolated wavelengths, a significant amount of development is necessary to make the technology

available at multiple wavelengths.

To advanced remote sensing techniques that will contribute to the ability to achieve persistent surveillance using advanced mid-and long-wavelength infra-red photodetectors.

33. Fluorescent Nano-Particles for High Efficiency Sensors

Questions on Topic 33 can be e-mailed to: topic33@icpostdoc.org

Proposed Research Project:
The purpose of this effort is to develop highly-efficient fluorescence-based sensors which might be used in the detection of very small levels of certain proteins or DNA. Labeling enzymes or complimentary strands of DNA with fluorescent dyes or "fluorophores" has the advantage of selectivity for a particular target molecule or agent. However, achieving the desired level of sensitivity, making the realization of practical field-based, real-time detection systems, is technically challenging. Photobleaching irreversibly deactivates fluorophores at too large an incident light intensity setting a limit to the signal achievable by merely illuminating the sensor with a very bright source. Background signal and signal-to-noise considerations on the other hand limit the efficacy of amplifying a very weak fluorescent signal optoelectronically. One potential technique for addressing these limitations that should be considered in this investigation is metal-enhanced fluorescence (MEF) (also referred to as surface enhanced fluorescence (SEF). MEF/SEF is an appealing candidate technique as the ratio of fluorescently emitted photon intensity to the incident intensity is enhanced if the fluorophores are in close proximity to certain metal particles of nanometer-scale dimensions. Measurements indicate that proximity of fluorophores to nano-particles produces increased fluorescent intensity and quantum yield while reducing the fluorescent lifetime. These effects combine to increase the photostability of the molecules, a desirable effect in a sensor application.

Technical objectives:
- Characterize the amplification of fluorescent intensity and quantum yield associated with pairs of nano-scale metals and flourophores when in close proximity.
- Characterize the impact to fluorescent lifetime associated with pairs of nano-scale metals and flourophores when in close proximity.

Goals:
Provide enabling technology to enhance to achievable signal-to-noise ratio in high sensitive and selective bio-hazard detection systems.

34. First Principles Modeling of High Energy Nanocomposite Metal Fluorides

Questions on Topic 34 can be e-mailed to: topic34@icpostdoc.org

Proposed Research Project:
Nanocomposites of metal fluorides have been shown to give more than 2x increase in energy density than cathodes used in current commercial batteries. In contrast to conventional insertion-type cathodes, metal fluorides represent a new class of conversion-type cathodes. However, much remains unknown about the conversion/reconversion mechanism in this new class of conversion-type cathodes. The objective of this project is to use first principles modeling to understand the conversion/reconversion mechanism in nanocomposites metal fluorides.

Technical Objectives:

- Investigate band gap and conductivity of doped fluorides-Better understanding of the conductivity will help us to overcome the rate limitation in this conversion-type nanocomposites cathodes.
- Investigate the conversion and reconversion mechanism of metal fluorides-Better understanding will help us improve the power capability and the cycle life of batteries based on the conversion-type nanocomposites cathodes.
- Extend the work to anodes other than Li-The goal is to identify the best anode to couple with the conversion-type nanocomposites cathodes in order to achieve the highest energy density.

Goals:
Results from the first principles modeling will allow us not only to understand the mechanism but also to identify or design the conversion electrodes that will yield the highest energy density in a practical cell. This modeling work will complement the experimental work and shorten the amount of development time needed to achieve revolutionary energy density improvement or drastic miniaturization of power sources for IC applications.

35. Analysis of Historical Acts of Accidental and Intentional Releases of Pathogens

Questions on Topic 35 can be e-mailed to: topic35@icpostdoc.org

Proposed Research Project:
The project will search literature and media available in the public domain to identify and subsequently evaluate historical acts of unintentional releases of pathogens and those associated biocrime, bioterrorism, and biowarfare.

Technical Objectives:
The project will identify potential indications and warnings (I&Ws) associated with each of the four types of pathogen releases and evaluate them for differentiating characteristics.

Goals:
I&Ws identified by the project will be tested for their usefulness in global situational awareness scanning systems.

36. Application of Bioinformatics to Pathogen Virulence and Detection of Genetic Engineering in Bacterial Genome

Questions on Topic 36 can be e-mailed to: topic36@icpostdoc.org

Proposed Research Project:
Genetic modification of microbial pathogens has implications for global public health, biomedical applications, and national security. Availability of massive and rapidly expanding genome sequence data sets in the public domain provides the opportunity to examine new bioinformatics approaches for extracting targeted information from this data.

Technical Objectives:
The project will develop and test new algorithms and models for analysis of genome sequences from microbial pathogens.

Goals:

- Provide genome sequence information for design of a chip that can detect evidence of genetic engineering of bacterial pathogens, and
- Predict the degree of virulence of microbial pathogens.

37. Entanglement-Based Sensing

Questions on Topic 37 can be e-mailed to: topic37@icpostdoc.org

Proposed Research Project:
Entanglement is an under-explored resource, and applications await discovery in sensing and imaging. Tremendous potential advantage of entanglement has been touted in the literature [Dowling]. The definitive demonstration of this advantage for practical applications could revolutionize sensing and imaging technologies.

Technical Objectives:
- Physical sensing demonstration
- Chemical/Biological sensing demonstration

Goals:
An orders of magnitude advancement of the state of sensing science via interferometry or otherwise.

38. Understanding Visual Change Perception in Unconstrained Environments Using Eye Tracking

Questions on Topic 38 can be e-mailed **to: topic38@icpostdoc.org**

Proposed Research Objective:
The proposed research effort is intended to investigate phenomena of visual change perception in unconstrained environments such as would be naturally encountered by analysts and users of intelligence.

Technical Objectives:

- Use the most advanced available eye-tracking tools to monitor visual behavior such as direction and length of gaze on a variety of visual materials representative of real-world environments (including direct observation as well as via media that convey observation)

- Determine the differences in behavior across the visual materials and their variations, and interpret the significance for improved human performance of visual perception tasks

- Consider the neural correlates of the perceptual data analysis, relating results of perceptual data analysis to advanced research regarding visual neuronal circuitry

Goals:
Goals might include the writing of a paper describing the nature of visual perception of change as studied, and predicting its implications and applications for presentation of visual materials (such as text, graphics, images) to those responsible for their comprehension, analysis and reporting.

39. What is Intelligence?

Questions on Topic 39 can be e-mailed to: topic39@icpostdoc.org

Proposed Research Project:
Background: Intelligence is widely understood to add reliability, timeliness, or advantage to decision making by making decision makers better able to understand their surroundings and act in ways that make those surroundings more profitable, or less threatening. At present, however, there is no shared understanding of the term "intelligence" that prompts consensus from scholars. Students and practitioners of the discipline of intelligence commonly employ the term to connote at least three things:

- Some experts view intelligence "as information for decision making"; i.e., a form of perception or situational awareness that an actor (whether an individual, organization, or state) uses to make sense of its surroundings.
- For others, intelligence connotes information specifically tailored for decision makers who operate in a competitive environment. The element of competition introduces a twist here by one, constraining the use that can be made of the information (so as not to give away a competitive advantage), and two, by expanding the definition of "information" to include the, if any, confidential or clandestine methods or sources by which that information is produced. Thus intelligence is not just information; it includes at least some measure of action to acquired the data.
- Still other experts argue that intelligence for nations is somehow different in quality or kind from other ways of acquiring and acting upon information. In this formulation, the key ingredient is not information but secrecy; the increased demand for security imposes such costs and constraints upon the decision making process that it transforms that process into something different in kind—not just in degree—from the first two types or understandings of intelligence. In this formulation, intelligence is secret information and action to understand and influence or act upon perceived threats, with both the information and action masked by secrecy that preserves their existence and facilitates, but does not ensure, their efficacy.

Technical Objectives:
The historical and scientific literatures offer explanations of each of these kinds of intelligence, but there is comparatively little exploration of the differences between them. Gaining such an understanding could clarify the nature and functioning of intelligence at all levels—personal, organizational, and national.

Goals:
Possible Hypotheses: Several potential avenues of enquiry look promising.

- Does the nature and severity of competition between actors lie at the root of the differences between the three kinds of intelligence? This seems like a simple question, but the answer may be elusive. The trick to answering it might lie in establishing the nature of the competition and gauging its severity. A successful proposal to get at this

issue might, seek to illuminate ways in which intelligence for states is similar and dissimilar to intelligence for individuals and/or non-state organizations. Note that, the definition of "states" is vague at this point so that proposal writers can have flexibility in bounding that parameter in their proposals.

- Claude Shannon's A Mathematical Theory of Communication [1949] posited that the more surprising a bit of information is to a consumer, the more valuable it is. Subsequent work may well have shed more light on this hypothesis. Does it have a theoretical or practical application to the ways in which decision makers view the intelligence they receive, and how they act upon it?
- In a more general sense, can the "utility" of intelligence be measured? People assume on a daily basis that intelligence has some value, but how do they know how much? An investigation along this line might examine how the utility of intelligence is in fact measured by nations and competitive enterprises (such as business that attempt to gauge the effect of intelligence on their "bottom lines.")

These ideas are meant to stimulate proposals for research; a successful proposal would not necessarily have to use any of these notions as its central hypothesis. We would welcome study proposals from across the social sciences, including, but not limited to, anthropology, sociology, psychology, political science, and economics.

40. The Cyber Revolution: A Global Alteration in Social Dynamics?

Questions on Topic 40 can be e-mailed to: topic40@icpostdoc.org

Proposed Research Project:
The world may well be undergoing a transformation in social dynamics, methods of production, and access to resources and information that is comparable to the Industrial Revolution. Like the Industrial Revolution, however, the transformation is not happening in a straight, linear fashion. As science fiction writer William Gibson reportedly quips, "The future is already here; it's just not evenly distributed yet." We can see people and groups who are far into that future (i.e., who routinely experience and participate in the emergence of a "networked world"), as well as others who have only begun to travel that path. Looking at what we can already observe about the changes fostered by the spread of what we might call "the cyber revolution," what can we say about how that transformation is occurring in ways that should interest or will affect America's security?

The goal of this project is to gain greater insight into how changing patterns of thought, behavior, and interaction are affecting the knowledge and wealth-creation aspects of the cyber revolution. Just how are computerization, miniaturization, and real-time, networked, global communications altering peoples' personalities, perceptions of self and others, beliefs, work, and social interaction in ways that must ultimately have a bearing on the topics and methods of intelligence work?

Technical Objectives:
Possible research areas (mentioned simply as illustrations and not as requirements or limits on a project proposal) might be:

- Do people behave differently on-line? What studies and data (as opposed to anecdotes) do we have on this issue?
- Is the wider diffusion of global databases helping or hindering the spread of knowledge? For example, are the restrictions placed on access to data trivial or serious, and what effects are they having in terms of creating "gated" communities of interest, or even fostering a culture of data theft (one contention in the struggle over music/video downloads)?
- How is the speed of computing and communicating changing perceptions of time, particularly in terms of shifting the balances in the classic economic and social trade-offs (such as speed v. accuracy)?
- Is networking creating global communities of interest that are more emotionally, intellectually, and even spiritually appealing than ties of family, clan, nation, or humanity? Should we expect shifts in loyalty to non-state actors, for instance, or new loyalty from people around the world who hitherto were not fully represented by the states in which they live?
- Does the spread of "cyber behavior" inevitably give rise to an anti-social reaction, and could that reaction (i.e., hacking, spying, sabotaging, and even terror) grow to proportions that will paralyze the global network?

Goals:
Research that increases our understanding of what is happening or has happened in the places and social sectors that have been leading the cyber revolution so that we can anticipate what will happen elsewhere as much of the world follows the transformation over the next generation. Particular interest in how people will act and what they will expect in a more fully networked world, and how their changing outlooks are themselves pushing the spread and refinement of cyber transformation.

For the purposes of this project, details like shifting consumer tastes, the economic indicators of the computer industry, or the science behind possible breakthroughs in processing capabilities are not of particular interest.

41. Language and Understanding: Does "Speaking the Language" Help Analysis?

Questions on Topic 41 can be e-mailed to: topic41@icpostdoc.org

Proposed Research Project:
The IC is investing in foreign language training and skill retention for analysts and collectors, under the assumption that there is a direct link between such skills and the quality of employee performance. While this link is obvious with respect to some collection specialties, it is less obvious on the analytic side; some have argued that language ability is primarily useful for cultural orientation but other skills (eg, inquisitiveness) are more germane.

Technical Objectives:

- To research the appropriate disciplines and examine/experiment with the following hypothesis "improving foreign language capability and cultural knowledge leads to improved analytic quality."
- We would welcome proposals to study the correlations, if any, between the analyst's mastery of a nation's language and the quality of the analysis that he produces.

Goals:
The goal is to research the potential correlation between foreign language training and analyst and/or collector quality of performance.

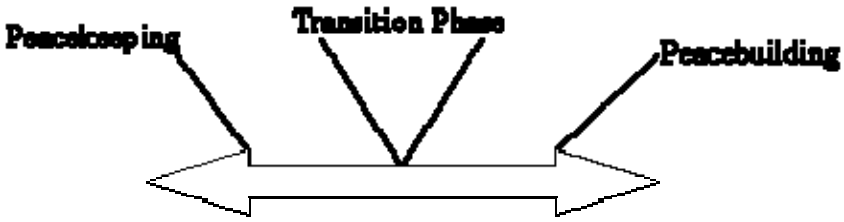
42. Peace Operations' Transition Phase: The Closing of Peacekeeping to Achieve Peacebuilding

Questions on Topic 42 can be e-mailed to: topic42@icpostdoc.org

Proposed Research Project:
The goal of this proposal is to advance open source intelligence in the field of peace operations by examining trends in the field as they relate to the closing of peacekeeping operations by the United Nations and their subsequent transition to peacebuilding—or any other type of—missions. In the graphic below, the "transition phase" should be the topic of this research. Possible research may include an examination of models to simulate the transition, previous experiences of such a transition (both good and bad) and proposals by think tanks, academic institutions and non-governmental organizations to make such a transition more seamless.

Technical Objectives:

- Content – Determine what the indicators of a "successful" peacekeeping operation are and what drivers are necessary for a country to move from one with an international peacekeeping presence to one with an international peacebuilding assistance presence. Create a definition, or definitions, of what "successful" means to the United States, the United Nations and the international community.
- Materials – Discover and possibly create tools for analysts in the IC to evaluate the "state" of a peace operation. Consider psychological variables that affect whether international organizations feel a transition is likely or even possible. Provide research that supports all gauges used to create such tools and examples of where they may have been used in the past.
- Presentation – Discover methods for presenting the indicators and drivers in a format that could be used in a training environment. This may involve research into existing training programs and concepts, computer simulation software, existing models and other factors.



Goals:
Possible outcomes from this research include a white paper or thesis describing the research in these areas. It also could describe the indicators and drivers in detail with an emphasis on variables that would change the likelihood of their impacts. In addition, a notional model of the transition phase could be created to use in support of the efforts raised in this research.

43. Efficient, Resource-bounded Information Gathering for Entity Resolution and Link Discovery

Questions on Topic 43 can be e-mailed to: topic43@icpostdoc.org

Proposed Research Project:
When building large knowledge bases or semantic graphs, it is often uncertain whether two hypothesized entities are actually the same person or different people. Similarly, knowledge about links or relationships between entities can be equally uncertain. When probabilistically-estimated certainty is below some threshold, these equivalences or links may be simply dropped--but sometimes the hypothesized information is too important to be ignored.

How can automated systems efficiently seek new evidence in order to increase the confidence about certain pieces of knowledge?

These are large, complex problems, involving probabilistic reasoning, joint inference, Bayesian networks, decision theory, Markov decision processes, resource-bounded reasoning, entity resolution, and link discovery. Entity resolution should be addressed in a unified setting that makes inter-connected, relational decisions, not separate pair-wise decisions. Relation or link discovery should also leverage unified inference procedures.

Technical Objectives:
This project will advance the state-of-the-art in reasoning about uncertainty in semantic graphs, and how to augment them from outside knowledge sources. It will discover new methods of applying efficient inference methods to large graphs. Specifically it will result in new, robust and scalable scientific methods for reducing uncertainty about entity resolution and link discovery in large knowledge bases or semantic graphs.

The main premise of the project is that information gathering is frequently an intermediate step in a decision-making process. By driving the information gathering process based on its contribution to decision making, it is possible to make better decisions within a small fraction of the time it takes to gather and extract a much larger portion of the available relevant information. The benefits of information gathering are measured in terms of the expected improvement in the utility of the best strategy using this information versus the currently computed best strategy. This framework can also be used to gather information that leads to the highest reduction in uncertainty.

Goals:
The two goals for the project are research publications and a demonstration system. Research publications and technical reports will detail the scientific advances and empirical results on large-scale test data, and will make them accessible to the IC community. The newly developed methods will be directly transferable to improvements in IC systems. The demonstration system will ensure that the developed methodology is practical, scalable, and gives good empirical results on real-world data.

44. Feedback Methods for Multiple Hypotheses Testing

Questions on Topic 44 can be e-mailed to: **topic44@icpostdoc.org**

Proposed Research Project:
Research within the scope of this topic also includes analysis of uncertainty in the presence of sometimes under sampled, noisy, and ambiguous data. The scope of the research includes both physics-related modeling behavior-based modeling and hypothesis testing. An example of physics-related modeling would be simultaneous dynamic adjustment of weather-driven models of multiple potential airborne chemical contaminants using continuous weather radar updates. An example of behavior-based modeling to detect anomalous behavior would be traffic modeling and detection of anomalies in an urban area for which dynamic traffic and accident updates are updated in real-time into the traffic models.

Technical Objectives:
Some elements within the scope of this topic include:

- Multiple hypothesis modeling of processes or behaviors via physics or rule-based theories; methods for including the null hypothesis within the hypothesis space for some problem projections are considered very important.
- Recognition of the uncertainties and inadequacies of the measurements and model parameters.
- Projection of the most effective measurements/collections and unknown range in model parameters for reducing the uncertainties.
- Imposition of collection constraints on collection optimization.
- Use of "expert opinion" in the effort to reduce uncertainties and ambiguities.
- Quantitative comparison of the likelihood of each of multiple hypotheses, including dynamic adjustment of the likelihood estimates based on the most recent data or projected successful collection.

Goal:
Research within this topic includes generalized techniques for simultaneous modeling of multiple hypotheses, dynamically testing of these hypotheses with feedback to the multiple models, and projection of "next measurements" that can optimally reduce ambiguities.

45. Trusted Information Sharing Research

Questions on Topic 45 can be e-mailed to: topic45@icpostdoc.org

Proposed Research Project:
The U.S. government benefits from the appropriate sharing of information across multiple organizations. In most cases, whether or not the information is "classified", it must be shared in a *trusted* way. The many factors that need to be considered when attempting to enhance the trusted sharing of information included technology, legal frameworks, organizations and culture. Too often, information sharing efforts fail to take into account the critical effect that all these factor have in determining whether or not individuals can or will share information with each other. Each of these factors profoundly impacts the others and cannot be considered in isolation from the effects of the other factors. Information sharing efforts that do not take account of all important factors are doomed to fail. Technological approaches that are not informed by organizational realities are rarely more than hollow exercises.

Technical Objectives:
Research is requested that addresses technological, organizational, legal, cultural, social, and human factors in an interconnected way. Some questions to consider are;

- How can technologists better understand information overload as it relates to the human consumer?
- How should government policies be changed to facilitate new technologies that may allow information sharing while preserving civil liberties?
- How should the enterprise properly incentives (and facilitate) information sharing organizationally and individually and how can technology enable this?
- How can the true value of effective information sharing be properly measured and assessed within and among enterprises?
- How can risk management of information sharing be properly and continuously implemented?
- How should all the multiple disciplines relevant to trusted information sharing be properly cross-pollinated and coordinated?

Goals:
Research that addresses technical approaches to trusted information sharing across and among enterprises with related but not identical organizational goals and constraints that also places great emphasis on the critical legal, social and cultural dimensions will be most valuable. A similar approach is also needed in scalable integrated solutions that can actually work in a government environment that must share *and* protect sensitive information.

46. Neural Correlates of Analytic Insight and Decision-Making

Questions on Topic 46 can be e-mailed to: topic46@icpostdoc.org

Proposed Research Project:
The human central nervous system (brain and sensory system) remains the most potent tool for intelligence analysis, far outstripping any artificial systems for analyzing deep intelligence problems. However, the interface between the external world and the brain remains a bottleneck. The challenge is two-fold. The delivery of new information to the analyst via traditional sources is limited by existing digital interfaces. Additionally, the decision-making processes of the mind may occur more rapidly than the analyst is able to communicate them. Thus, there may be additional efficiencies to be gained by understanding the neural mechanisms involved in complex decision making and analytical insight.

Work supported by the DoD and Intelligence Community has shown that there are novel methods for interfacing the brain and the outside environment. Work at Columbia University and other institutions has shown that neural correlates for target detection exist and can be extracted and characterized in real-time. Efforts such as the joint DARPA-NGA 'Neurotechnology for Intelligence Analysts' program will exploit these brain signal for geospatial intelligence problems, with the explicit goal of developing tools to speed the imagery analysts work process. However, additional research is needed to fully understand the nature of complex analytic phenomena in the brain.

Technical Objectives:

- Investigate the signals generated by the human brain as it performs different analytic tasks. Characterization of signals, including the loci of generation, the type of signals (frequency information, spatiotemporal details), and measurement of synchrony with other neurophysiological signals are of particular interest in this specific domain. This would represent novel and critical work that could be applied to development of human computer interface tools..
- Understand how the human brain processes information across modalities in a complex decision making environment. Can efficiencies be found by presenting information across multiple sensor inputs? Do auditory, visual, tactile, and olfactory stimuli share common signal properties? A better understanding of the phenomenology of the activities observed in the brain will form the basis for better models that can be used to develop better visualization and multi-INT fusion tools.

Goals:
This topic will investigate novel ways to apply neurophysiological research in the intelligence domain. It will enable the development of new tools and interfaces for the intelligence community, facilitating new analytic insights and accelerating the synthesis of data to information and finally the generation of new hypotheses.

47. Electro-optic Polymer Technology for Very Wide Bandwidth Systems

Questions on Topic 47 can be e-mailed to: topic47@icpostdoc.org

Proposed Research Project:
Within the U.S., there is interest in next generation technology employing electro-optic techniques to support instantaneous bandwidths greater than 20 GHz. This is particularly true due to recent advancements in organic polymer materials development coupled with device fabrication techniques where very significant results are close to being achieved in a single device configuration with the following attributes: low noise figure (3 dB), low drive voltage (0.8V), high linearity and low losses, low V_π (0.25V), high glass transition temperature (T_α =80C), and low insertion losses (3 dB).

Technical Objectives:
The purpose of this postdoctoral research topic is to develop new insights and perspectives in this area of research so that it can rapidly be brought to a level of maturity appropriate for its adaptation to capabilities of significance to the IC. Specifically, the researcher is to model, design, build, and test innovative Mach Zehnder modulators using optimized materials technology and device techniques that demonstrate performance superior to state-of-the-art lithium niobate technology.

Goals:
To advance next generation technology employing electro-optic techniques to support instantaneous bandwidths greater than 20 GHz for its adaptation to capabilities that are of interest to users anticipating future, demanding requirements.

II. AWARD INFORMATION

Note: Only procurement contracts will be awarded as a result of this BAA. Grants, Cooperative Agreements, and/or any other form of federal assistance will not be awarded.

Through this competition, NGA/ITIC expects to make three or more contract awards in specific research topics. All contract awards will be based on merit competition. Depending on the quantity and quality of proposals received, NGA/ITIC may not make any contract award(s) under a particular research topic. If more funds become available, additional contracts may be awarded at a later date based on initial evaluation results. Typically each contract award will be:

- For a basic period of one year (funded incrementally), with an option for a second year; a third year may be awarded based on the IC community's continued interest in the topic and progress and participation of the recipient, and,
- For the amount of $120,000 per year/per contract.

This IC Postdoctoral Research Fellowship Program competition is specifically for the research topics described in paragraph I. B. Offerors are advised to read this announcement carefully. It explains the program research needs upon which the topics are based and the terms and conditions of this competition.

This BAA is being publicized at www.fedbizopps.gov and www.nga.mil .

III. ELIGIBILITY INFORMATION

A. Eligible Applicants

Proposals must be submitted by a principal investigator / mentor associated with a U.S.domestic, non-profit/not-for-profit organization. **Although all research in this program is unclassified, each Postdoctoral Fellow must be a U.S. citizen.** The principal investigator / mentor is **NOT** required to be an U.S. citizen. Proposals not meeting these eligibility requirements will not be considered.

B. Cost Sharing or Matching

There is no required cost sharing or matching.

IV. APPLICATION AND SUBMISSION INFORMATION

The Government will evaluate all proposals submitted under the terms and conditions of this BAA. Government-paid consultants or subject matter experts may be involved in the evaluation and selection processes.

A. Address to Request Application Package

This announcement contains all necessary information to apply. No application kit is required.

B. Content and Form of Application Submission

The Intelligence Community is concerned with research in specific areas of science and engineering. For this reason, all proposals must adequately describe the technical objectives and approaches, support of principal investigator and Postdoctoral Fellow, and expenditures for equipment, all of which will be evaluated by qualified reviewers per paragraph V. .

Proposals must be complete and self-contained to qualify for review. Separate attachments, such as institutional brochures or reprints that are not germane to the proposal, are discouraged. Proposals shall be prepared single-spaced in 12-point Times New Roman font, with at least one-inch margins on top, bottom and sides, on 8½" by 11" pages. Proposals shall be formatted as one .doc file of a size not to exceed 3 Megabytes. Compressed archive ("zip") files are not acceptable. The proposal shall include all of the following items:

1. Cover Page

The cover page shall include the BAA number (HM1582-06-BAA-0002), proposal title, and topic or research area of interest. The cover page also must indicate the name, phone number, fax number, postal address, and e-mail address of both the principal investigator and an appropriate official in the organization's research administration office. A DUNS number, TIN number and CAGE shall also be provided.

2. Project Description

The project description portion of the proposal is limited to three pages and shall:

a. Describe the proposed research objectives and approach to be undertaken. State the objectives and approach and the relationship to state-of-knowledge in the field and to similar work in progress. Include appropriate literature citations and prior work.

b. Discuss the nature of expected results.

c. Describe the expected outcomes and relevance to the Intelligence Community research need.

d. Identify other parties to whom the proposal has been/will be sent.

3. Resume

The resume shall be limited to two (2) pages each and shall provide the credentials of the principal investigator, demonstrating why the offeror is qualified to do the work proposed. If a Postdoctoral Fellow has been identified, an additional resume, two (2) pages in length, also may be included.

4. Cost

Beginning on a new page, the financial portion of the proposal should contain cost estimates in sufficient detail for meaningful review. The annual cost must be no greater than $120,000. At least $60,000 of this cost should be allocated for direct support of one full-time Postdoctoral Fellow, including salary and fringe benefits. The remaining funds can be allocated to a fraction of the principal investigator's time, unique equipment needed to conduct the proposed research, other direct costs. For proposal purposes, use the later of the estimated award start date or the offeror's proposed start date. Exceptions to the above-recommended allocation will need to be approved by ITIC. The cost proposal must include the total cost of the project, as well as a breakdown of the amounts by source of funding (e.g., funds requested from the IC Postdoctoral Research Fellowship Program, and/or institutional funds to be provided as cost sharing). The costs should be broken down for each year of the program and shown by three distinct totals: a total for the basic year and a total for each of the optional follow-on years.

The estimated contract start date should be used for budget and proposal purposes. **You may, however, request a later start date and may therefore develop your budget based on your proposed start date.**

Although expected to be short, there is no page limit for the cost section of the proposal. Cost elements should include, but are not limited to:

a. Time being charged to the project by the principal investigator and Postdoctoral Fellow, and their commensurate salaries and benefits.

b. Costs of equipment based on most recent quotations and broken down in sufficient detail for evaluation (equipment costs should be budgeted primarily during the first year). Allowable equipment will ordinarily be limited to research equipment and apparatus not already available for the conduct of the work. General-purpose equipment, such as a personal computer, is not eligible for support unless primarily used in the actual conduct of the proposed scientific research.

c. Travel costs and time, and the relevance to stated objectives. This shall include a breakdown of the name and number of travelers, location and duration; and estimated costs for transportation, rental car and per-diem. This shall also include travel for the required attendance at the annual IC Postdoctoral Research Fellowship Program colloquium in the spring of each year. The 2007 colloquium will be held in the Washington, D.C. area on dates TBA in April, 2007.

d. Other direct costs such as materials and supplies; publication, documentation and dissemination; computer services; communication costs not included in overhead; or others (identify). Backup information, to support these costs, shall also be submitted. These costs shall include at least one published article per year and submission of the corresponding abstract to the Journal of Intelligence Community Research and Development (JICRD). This published article will

need to be coordinated, vetted and submitted through the IC Advisor.

e. Indirect costs.

C. Submission Dates and Times

ITIC, through NGA as the executive agent, intends to award with FY2006 funding. To be considered and evaluated, the Government must receive the full proposal by **5:00 PM (EST), 14 April 2006**. Submission time will be determined by the date/time stamp of the transmitting email message adjusted to Eastern Standard Time. If a proposal is submitted in an untimely manner (after 5:00 PM, EST on 14 April 2006) the criteria in Federal Acquisition Regulation part 15.208 will be followed.

NGA will send the offeror an acknowledgment of receipt of the submission, and will follow-up later with a notification letter announcing whether the proposal is being recommended for an award. Acknowledgment and notification will be sent to the principal investigator via e-mail, according to the schedule in paragraph IV. C. , with a copy to the appropriate organization administrative office.

C. Funding Restrictions

The proposed annual cost must be no greater than $120,000. At least $60,000 of this cost must be allocated for direct support of one full-time Postdoctoral Fellow, including salary and fringe benefits. The remaining funds can be allocated to a fraction of the principal investigator's time, unique equipment needed to conduct the proposed research, other direct costs. Awards do not allow reimbursement of pre-award costs.

D. Other Submission Requirements

Proposals must be complete and self-contained to qualify for review. Proposals shall be prepared single-spaced in 12-point Times New Roman font, with at least one-inch margins on top, bottom and sides, on 8½" by 11" paper. Proposals shall be formatted as one .doc file (or "zipped".doc file) of a size not to exceed 3 Megabytes. The Government's mail servers will not accept files of a greater size. The proposal shall reference BAA Number HM1582-06-BAA-0002. Proposals shall be submitted electronically by e-mail to prfp06-2@westfields.net. In the event of system problems when submitting a proposal, contact one of the Points of Contact listed in paragraph VII. .

V. APPLICATION REVIEW INFORMATION

A. Criteria

1. Initial Evaluation Criteria

The initial evaluation criteria used to determine if an offer is "selectable" are:

a. The qualifications of the principal investigator and Postdoctoral Fellow (weighted 50%);

b. Scientific and technical merits of the proposed research (weighted 30%);

c. Relevance and potential contributions of the research to the Intelligence Community's missions (weighted 20%); and,

d. The realism and reasonableness of cost, including proposed cost sharing. Evaluation of cost shall be based on cost realism as it relates to the Government's degree of confidence in the offeror's ability to perform the proposed work at the proposed cost (evaluated as pass/fail).

2. Final Evaluation Criteria

The final evaluation criteria used to determine the priority of a "selectable" offer for funding are:

a. The numerical score from the "selectable" evaluation.

b. The potential contribution to the advancement of the targeted technical topic(s).

c. The amount of similar or related research already underway on a given topic.

B. Review and Selection Process

The Intelligence Community Advisors will independently review the proposals, evaluating them in accordance with all the evaluation criteria of paragraph V. A. of this document, and completing a set of Evaluation Worksheets for each proposal. Proposals will be grouped together by specific research area. One expert team will evaluate all proposals in the same group. Out of all the proposals evaluated in the same group, the expert team will prioritize and recommend one or more proposals as they determine to be "selectable."

Next, all the recommended selectable proposals will be discussed by an Evaluation Panel consisting of the agency points of contact, the NGA executive agent and the IC Postdoctoral Research Fellowship Program Manager. The panel anticipates awarding a minimum of two awards to each identified agency (CIA, NGA, NRO, NSA, and DIA). The panel will convene and will consider the overall contribution of each "selectable" proposal as reflected by the numerical score, the potential contribution to the advancement of the targeted technical topic(s), the amount of similar or related research already underway on a given topic and the amount of available funding. This step brings a cross-discipline balance to the selection process, reconciles recommendations about proposals spanning more than one technical area, and allows for strategic consideration of the diversity of proposals across the topic areas. While it is the panel's intent to make at least two awards to topics submitted by each of the five identified agencies, the final outcome may not reflect this intent. In summary, the combination of "selectable" proposals that most effectively advances the IC's research program will be recommended for award. The number of awards made is dependent upon the amount of available funding. If additional funding becomes available from within the community or from other U.S. Government agencies, the program may choose to make additional awards under the terms of this BAA from the remaining selectable proposals. The sponsoring organization will be free to support any "selectable" proposal(s) that addresses the

research interests of that organization.

The list of proposals recommended for award, along with a description and results of the evaluation process will be forwarded to the Director of Intelligence Technology Innovation Center (ITIC) for approval. When approved, the award list will be forwarded to the Contracting Officer for award action to include, as necessary, cost analysis and contract negotiation. Awards will be made upon successful negotiation.

C. Anticipated Announcement and Award Dates

The following table provides the significant dates referred to in the body of this announcement.

Action	**Responsibility**	**Due Date**
Broad Area Announcement	Government	17 February 2006
Proposal due	Principal Investigator	14 April 2006
Acknowledge receipt of proposals	Government	21 April 2006
Letter of intent to recommend for award and declinations	Government	30 June 2006
Estimated start date	Principal Investigator	1 July 2006
IC Postdoctoral Colloquium (required attendance)	Government, Principal Investigator	TBD April 2007

VI. AWARD ADMINISTRATION INFORMATION

A. Award Notices

Notification announcing whether or not the offeror's proposal is being recommended for an award will be e-mailed directly to the University Grant Administration Office. Awards are expected to be in place by the proposed start date or the start date identified in paragraph IV. C. , whichever is later.

B. Administration and National Policy Requirements

Awards will be made for one year with two one-year options. The Government expects to exercise the first year option assuming quality research is ongoing. The second year option will be the exception, rather than the rule. The awards will be incremental funded at funding levels no greater than $120,000 per year, per award/option period.

Once a proposal is selected for award, one of two scenarios will be executed:

1. If a postdoctoral candidate is already identified and prepared to begin the proposed

research, 100% of the first year's award funding will be provided by the start date.

2. **If a qualified postdoctoral candidate must be sought, $10,000 of the award amount will be provided initially, with the remaining first year's funding provided when the qualified candidate is identified and selected by the organization.**

C. Reporting

An annual report is required after each year of the fellowship, NLT 60 days from the anniversary date of the award. The report should address the accomplishments for the year and provide a listing of all publications and presentations arising from the research project. Copies of the annual report and referenced publications and presentations will be submitted in hard- and soft-copy to the IC Postdoctoral Research Fellowship Program Manager, IC Advisor for the project, and the Journal for Intelligence Community Research and Development (JICRD) for publishing in the JICRD On-line Research Journal. Contact information will be supplied when the contract is awarded. All IC Postdoctoral Research Fellows are required to attend and present at the Annual IC Postdoctoral Research Fellowship Colloquium held in the Washington, DC area in April each year.

VII. AGENCY CONTACTS

A. Contracting Point of Contact

Sharon M. McDowell at 703-735-3043

B. Administrative Issues Points of Contact

Dr. Scott Loomer at 703-735-3062

Mr. Tom Kennedy at 703-874-0689